Anvil LCC Analyses

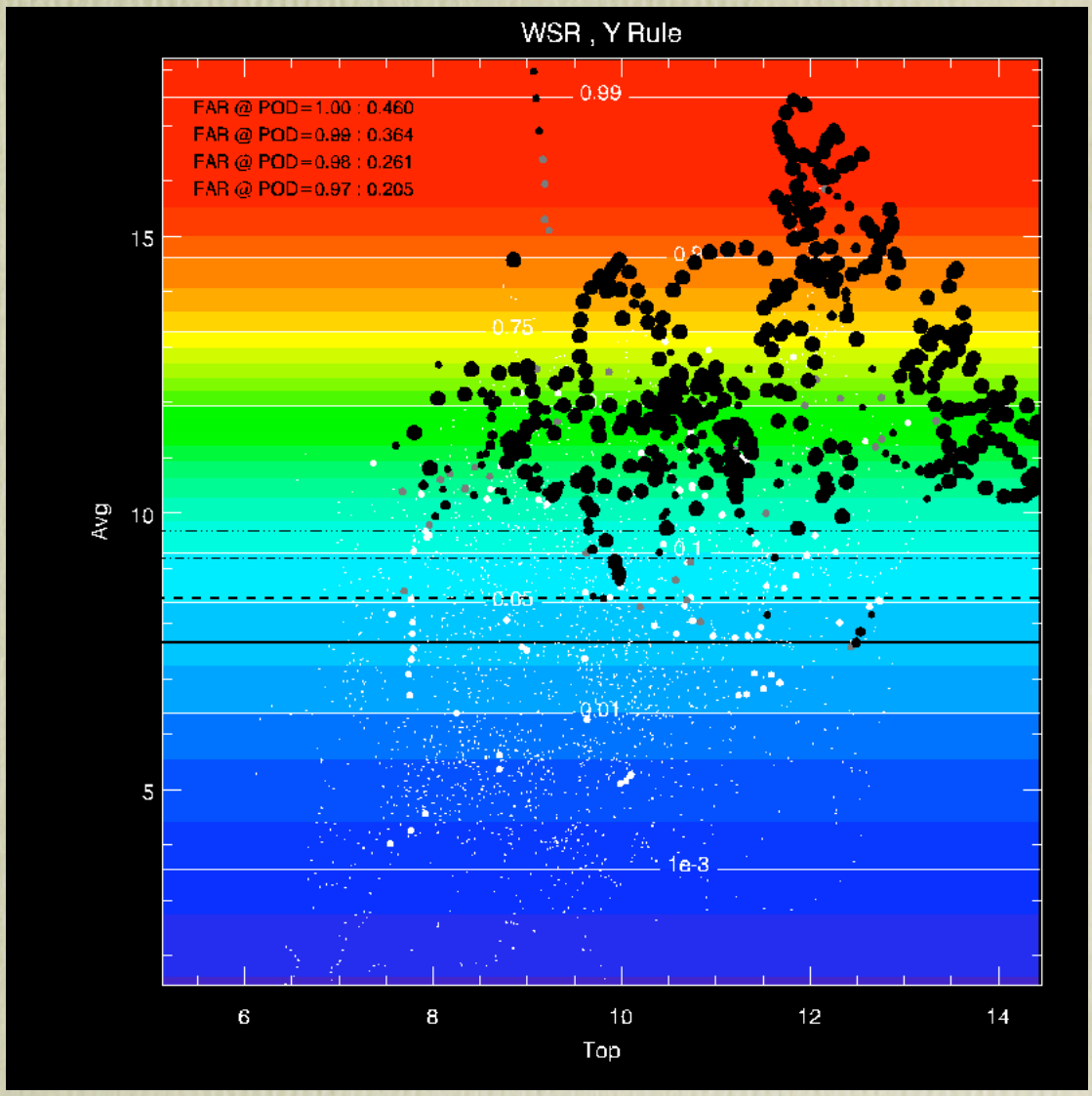
Examples:

Pairwise data visualization and model-fitting.
Hopefully this type of plot will allow us to assess both statistics and physics simultaneously.

How to read these plots

Scatter points:

•	E < 2	Non-hazard
•	2 < E < 3	
•	3 < E < 4	
•	4 < E < 7	Hazard
•	7 < E < 10	
•	E > 10	

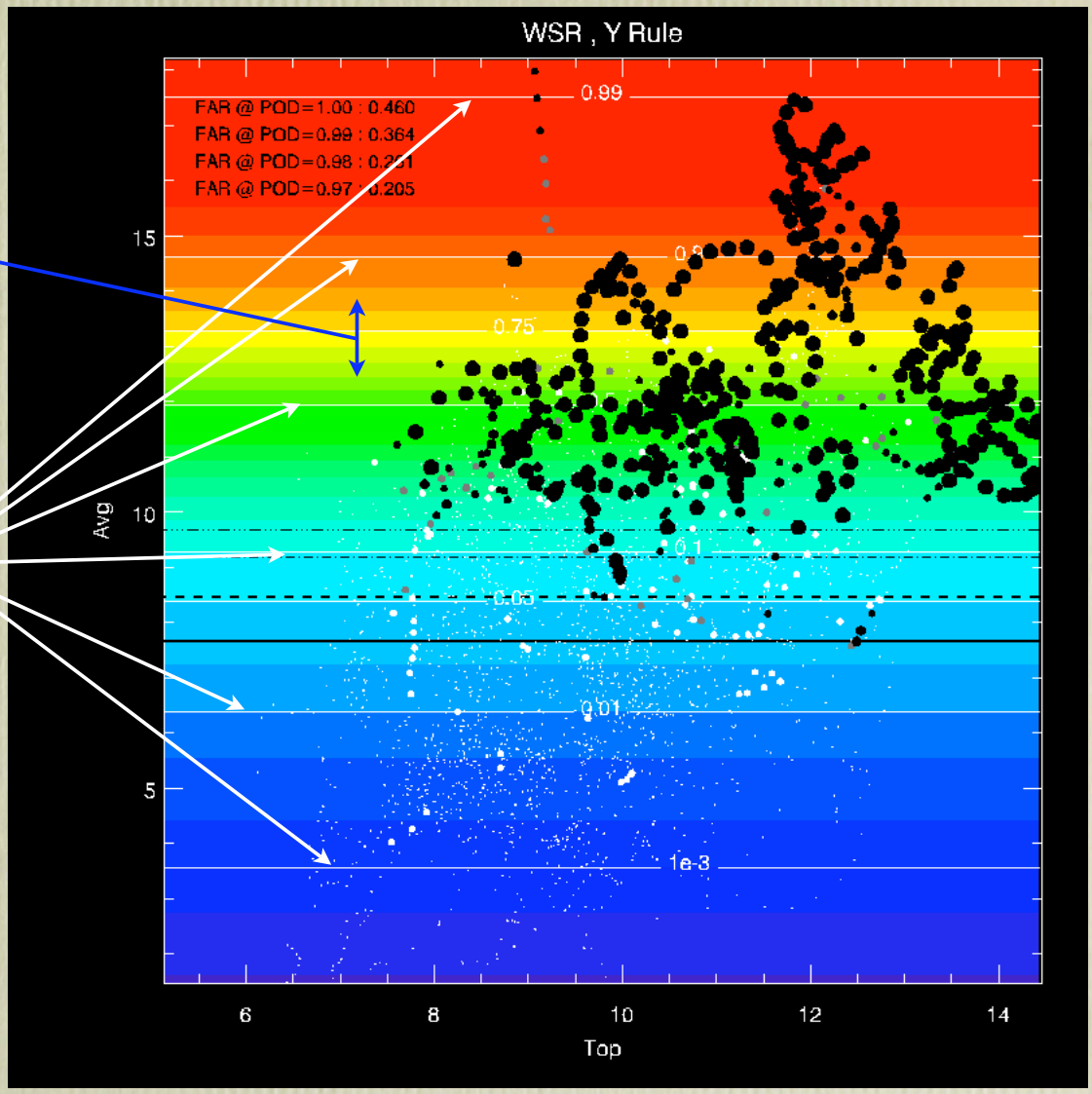


How to read these plots

Model output hazard (E > 4) probability (continuous)

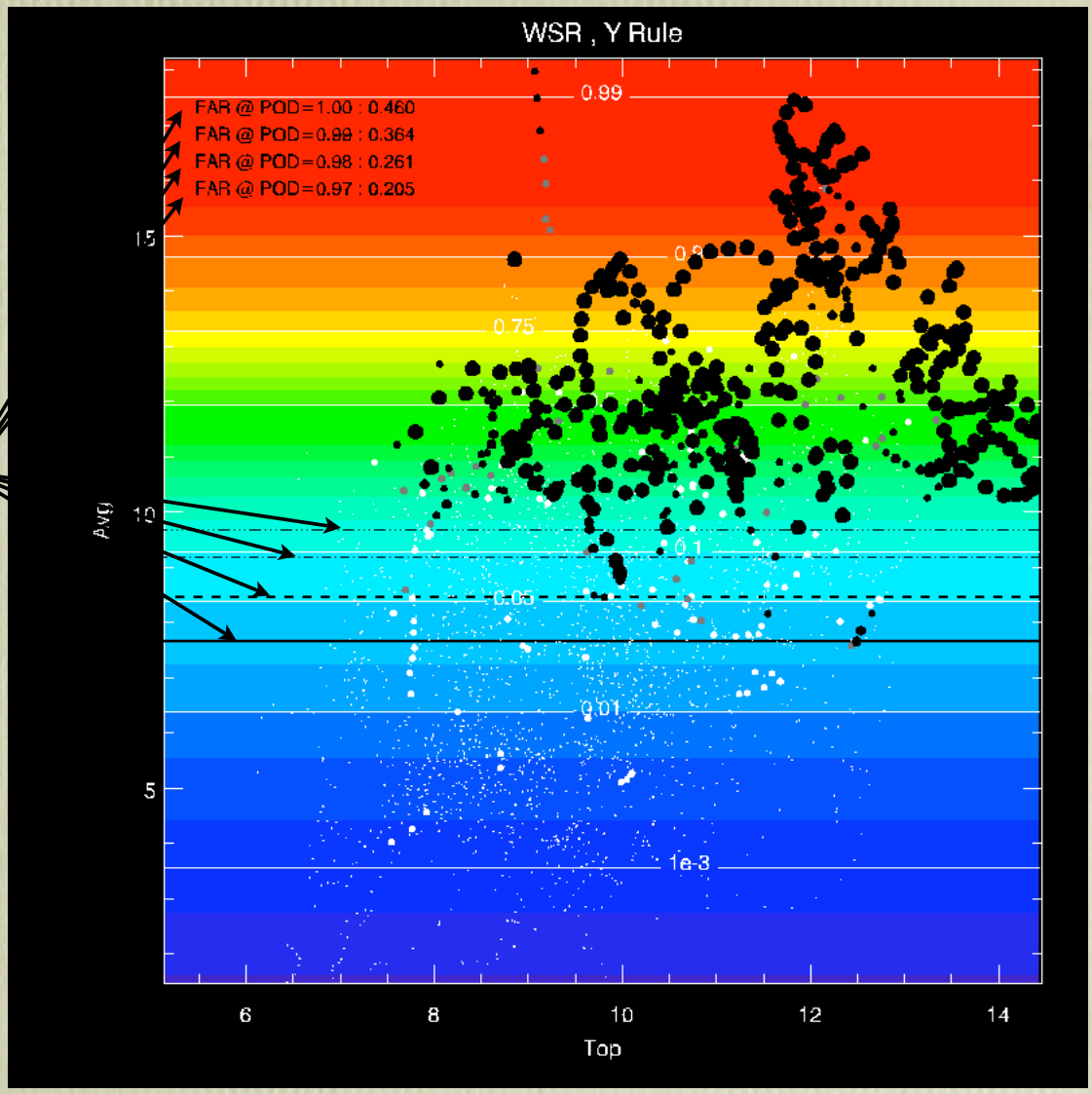
(1e-3, .01, .05, .1, .5, .75, .9, .99 probability contours)

*In this case, a threshold rule model's output (Avg) is shown as a probability



How to read these plots

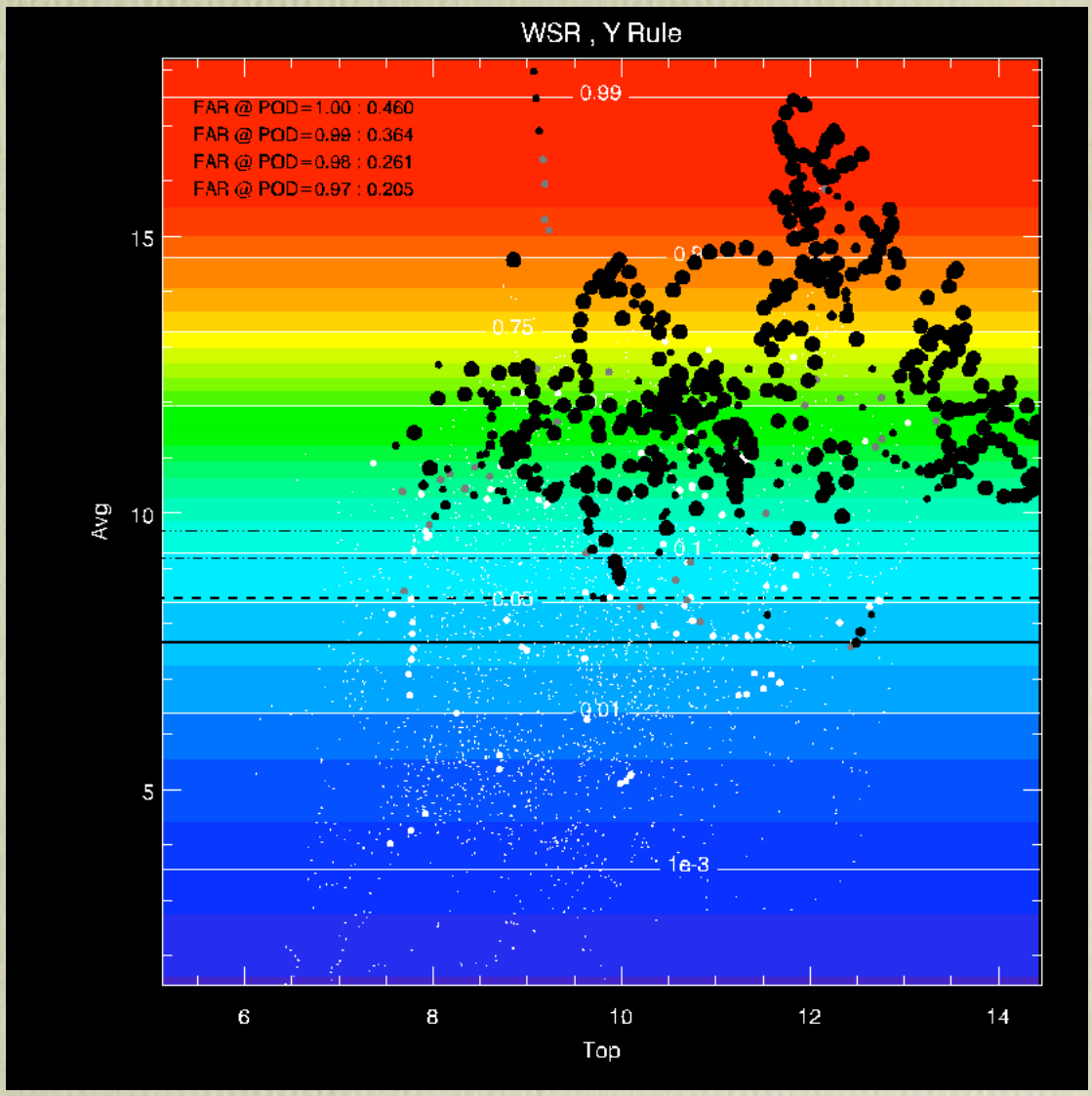
Decision thresholds (probabilities) corresponding to POD = 0.97, 0.98, 0.99, 1.00, and corresponding FAR



* E.g., POD=1.00 Avg threshold corresponds to a ~ .03 probability and 0.46 FAR

Threshold rule on Avg (WSR)

No marginal cases (grey circles, 3 < E < 4) below the POD=1 contour, this is good



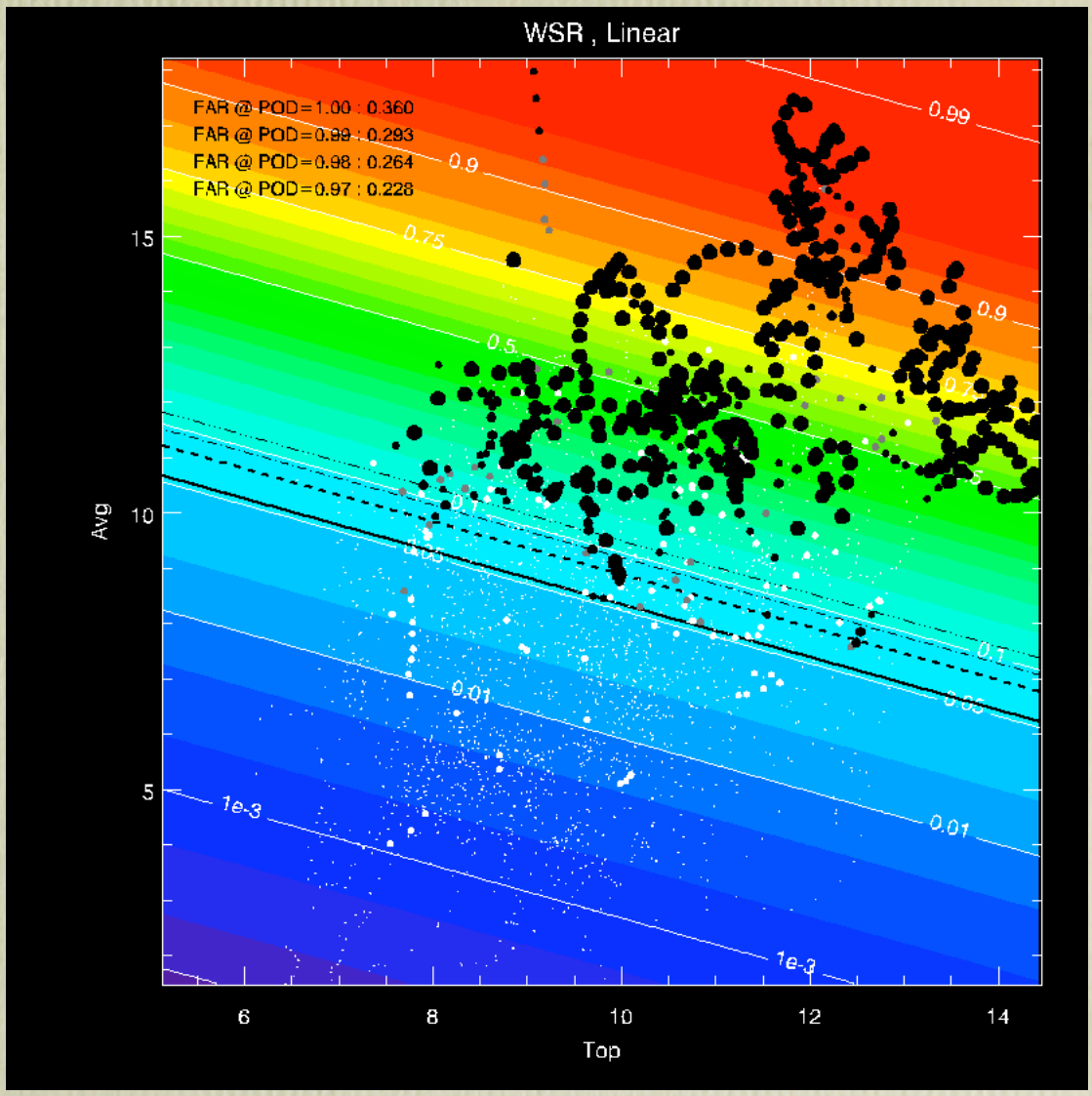
Linear model, Top and Avg, WSR

Interpretation: "The same AVG is *more* of a threat in deeper-topped clouds"

Note: The Avg-only threshold rule is *not necessarily* the most conservative model. This model indicates that deep clouds (>~ 11 km Top) with Avg below the thresholds from the previous slides are also hazardous.

Conversely, the Avg threshold is overly conservative for shallow clouds (<~ 11 km Top).

In this case, this reduces FAR.



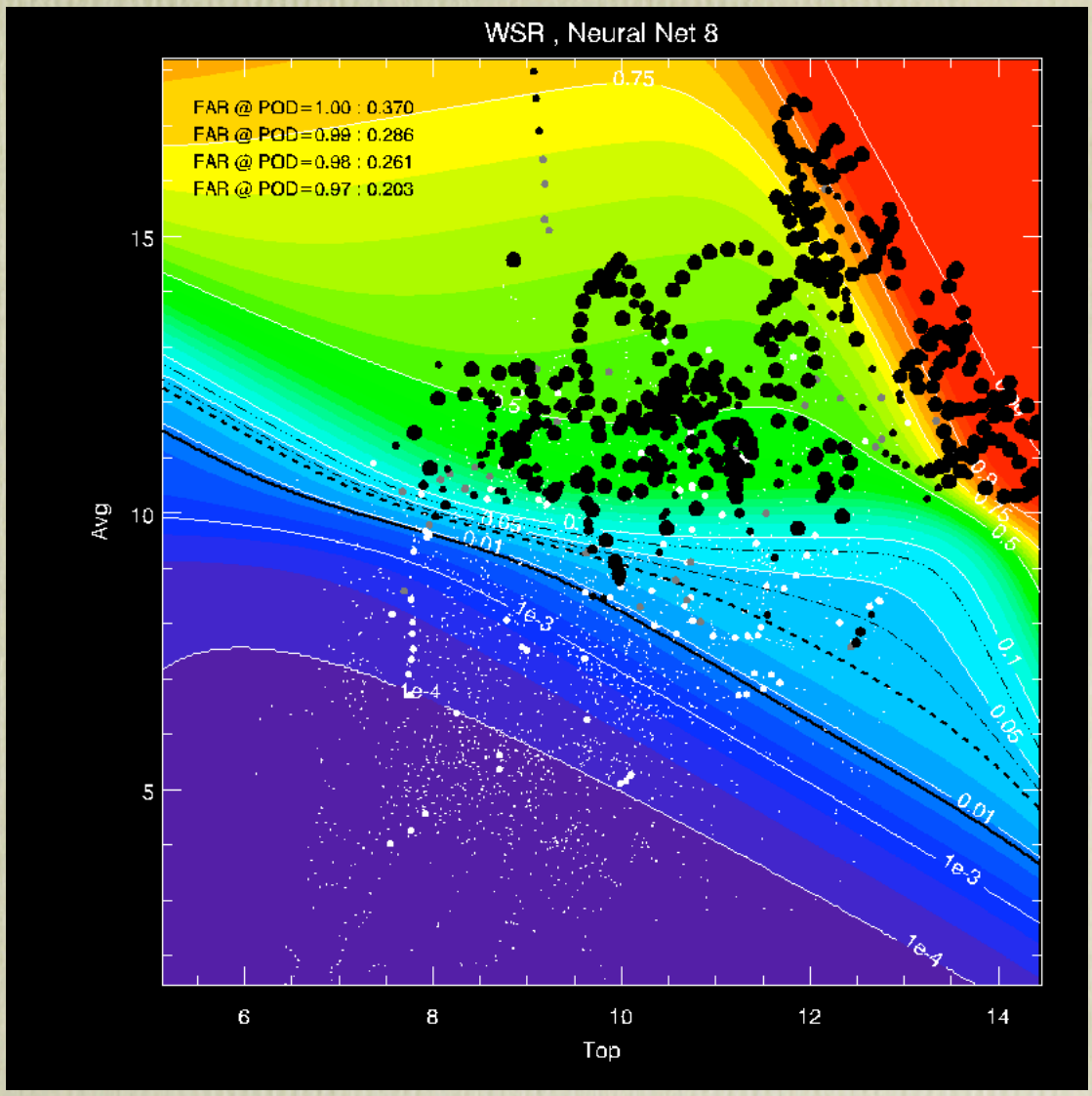
Nonlinear model, Top and Avg, WSR

Interpretation: "The same AVG is *more* of a threat in deeper-topped clouds"

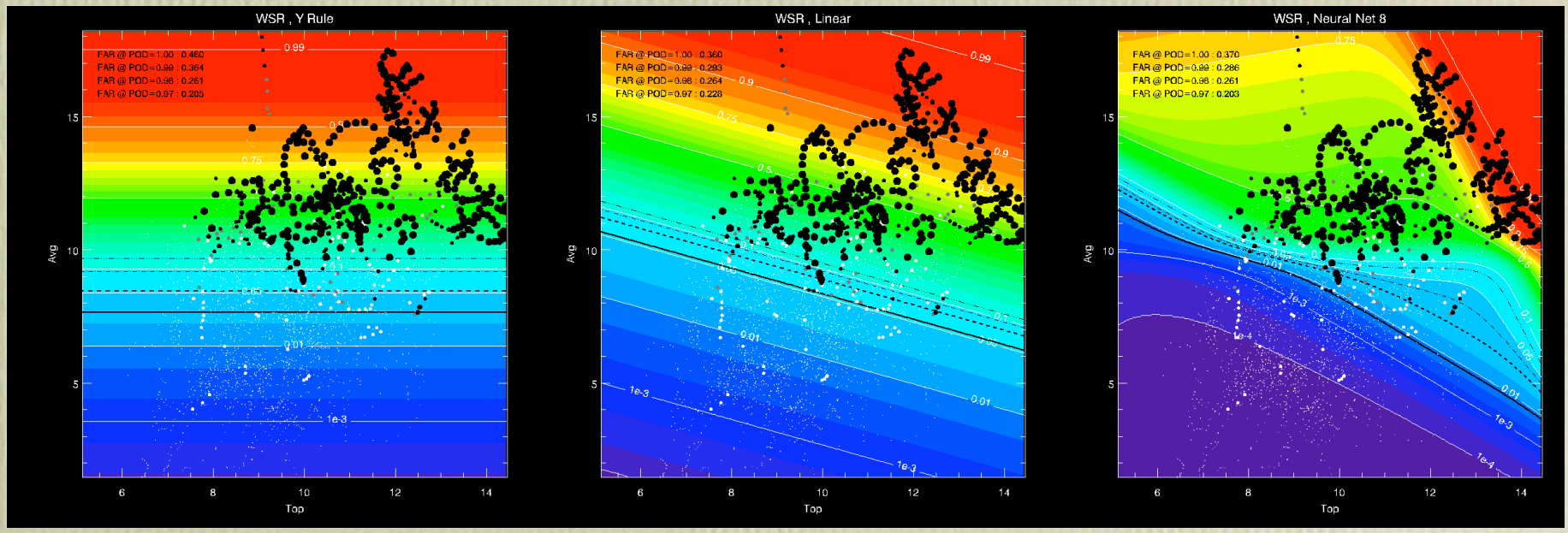
Think of the color contours as smooth approximations to the actual bivariate hazard density (ratio of black to total points at a given "grid" location), *if* we had infinite data. For that is what they are.

The neural network "finds" a similar conclusion as the linear model. FAR is about the same as the linear model, unless we choose a POD=0.97 threshold, which considers apparently truly hazardous points as outliers.

The black contours still represent decision thresholds - exactly as in the rule based model.



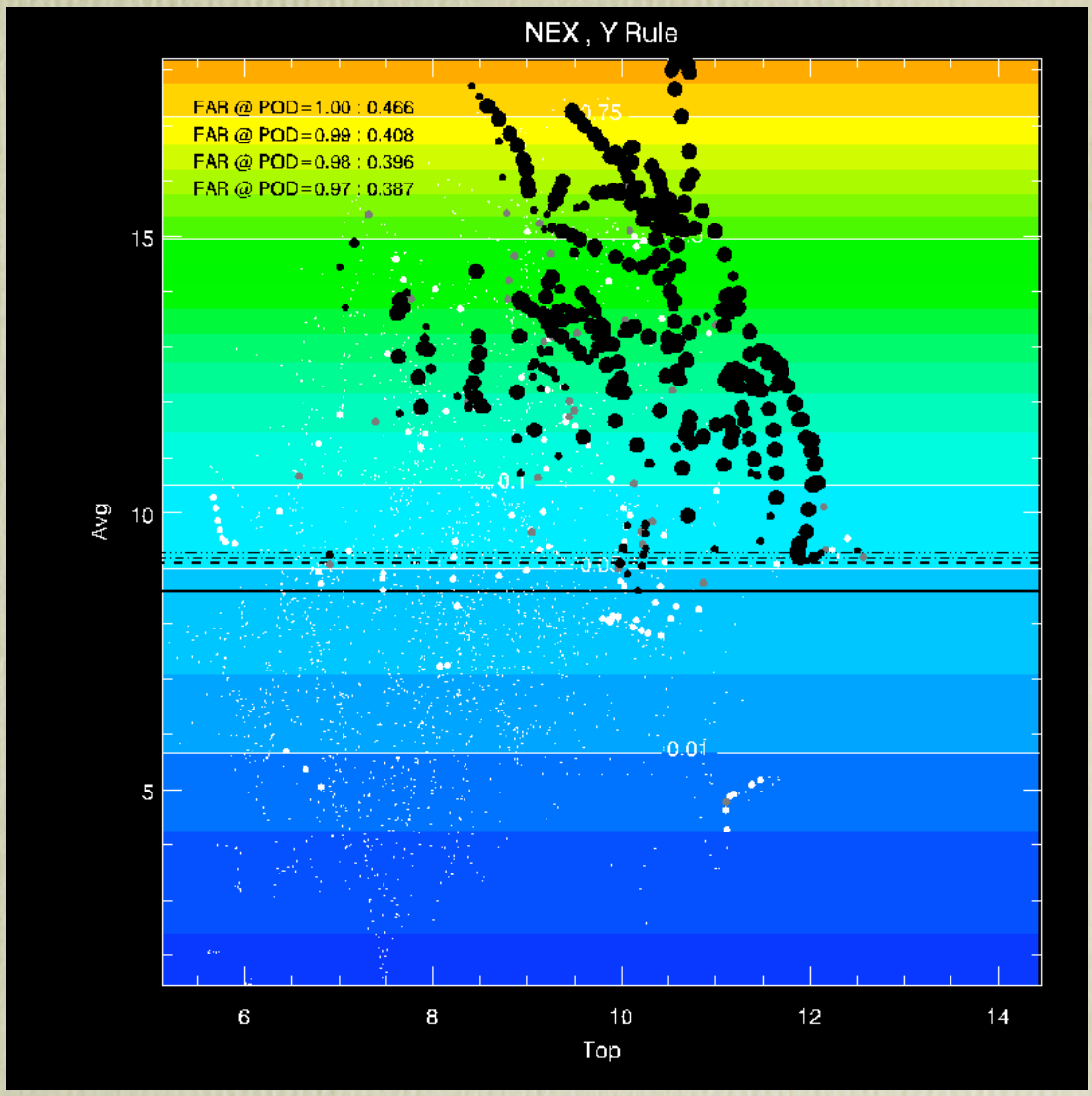
Top and Avg, WSR, side-by-side



Threshold rule on Avg (NEX)

Threshold similar to WSR

Note hazard cases with lower Top than WSR. An outlier?



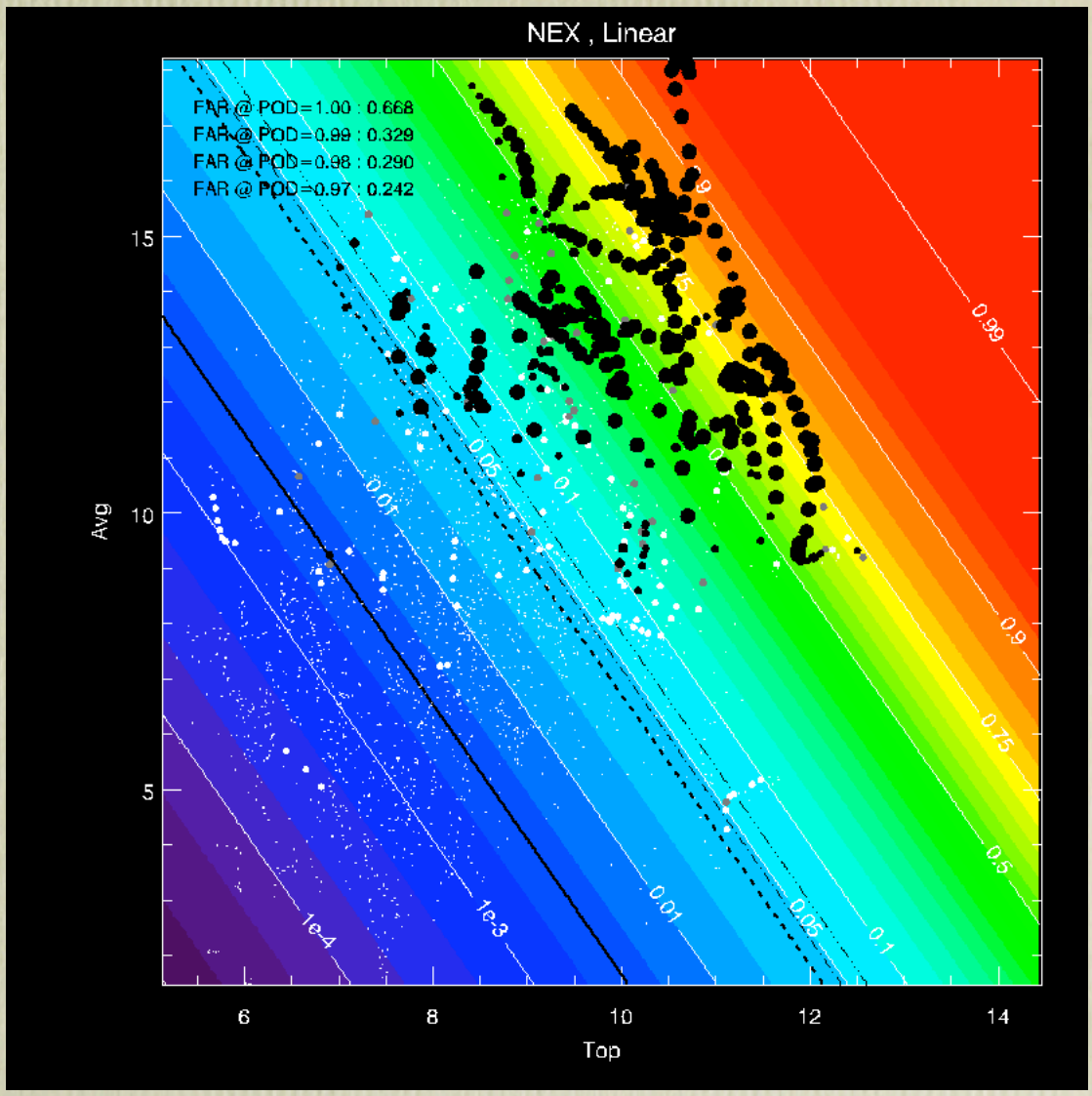
Linear model, Top and Avg, WSR

Interpretation: "The same AVG is *more* of a threat in deeper-topped clouds"

Same conclusion as WSR.

Possibly corroborated by the grey (3 < E < 4) and white (2 < E < 3) near-hazard observations at 11 km, 5 dBZ

What to make of the hazardous "outlier" at 7 km, 9 dBZ? This drives our POD=1.00 threshold and trashes FAR. FAR for POD=0.99, 0.98, 0.97, though, is *better* than Avg-only rule.



Nonlinear model, Top and Avg, WSR

Interpretation: "The same AVG is *more* of a threat in deeper-topped clouds"

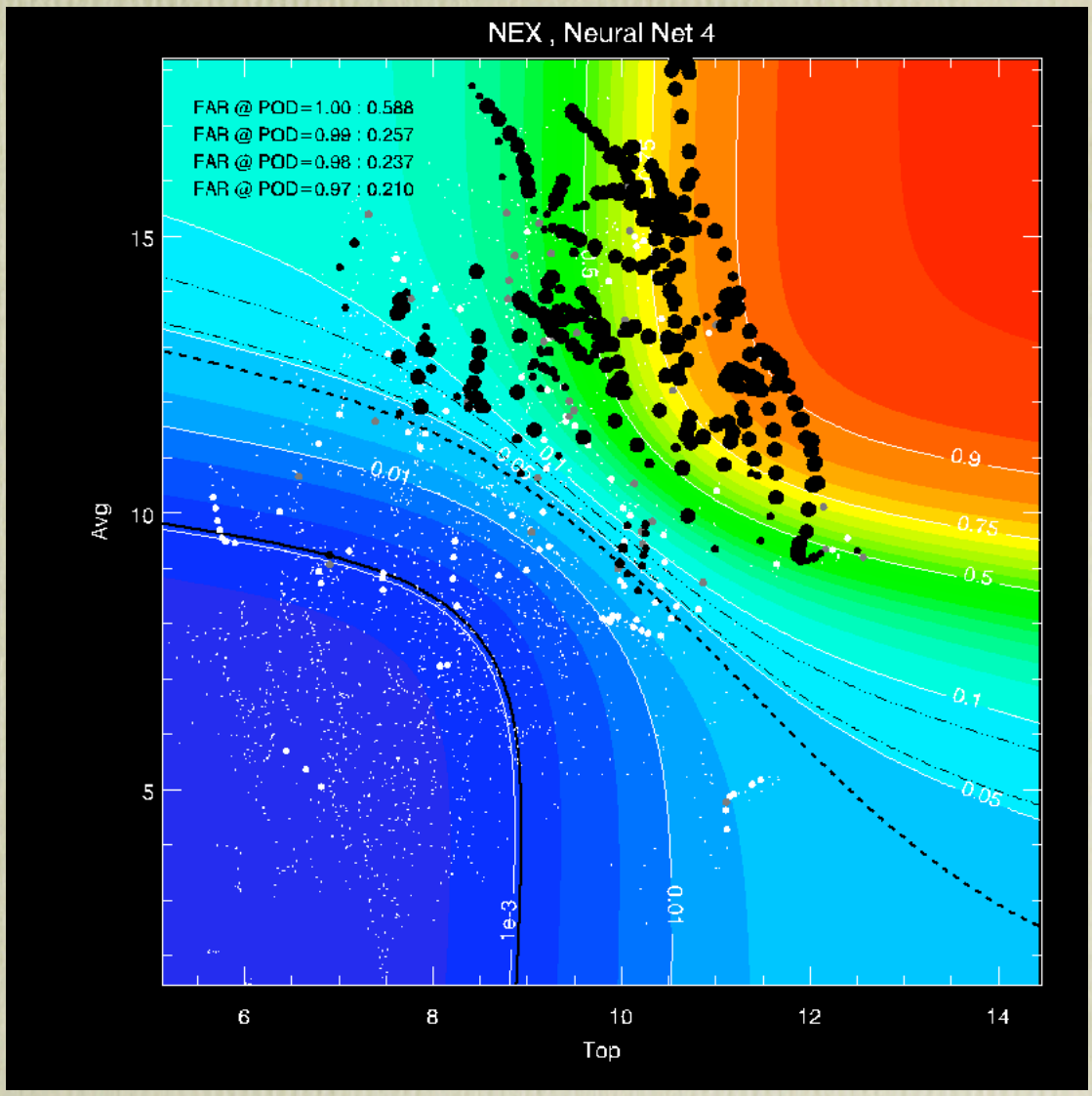
Similar overall conclusion to WSR.

The POD=1.00 threshold must accommodate the 7 km / 9 dBZ "outlier", thus FAR is trashed.

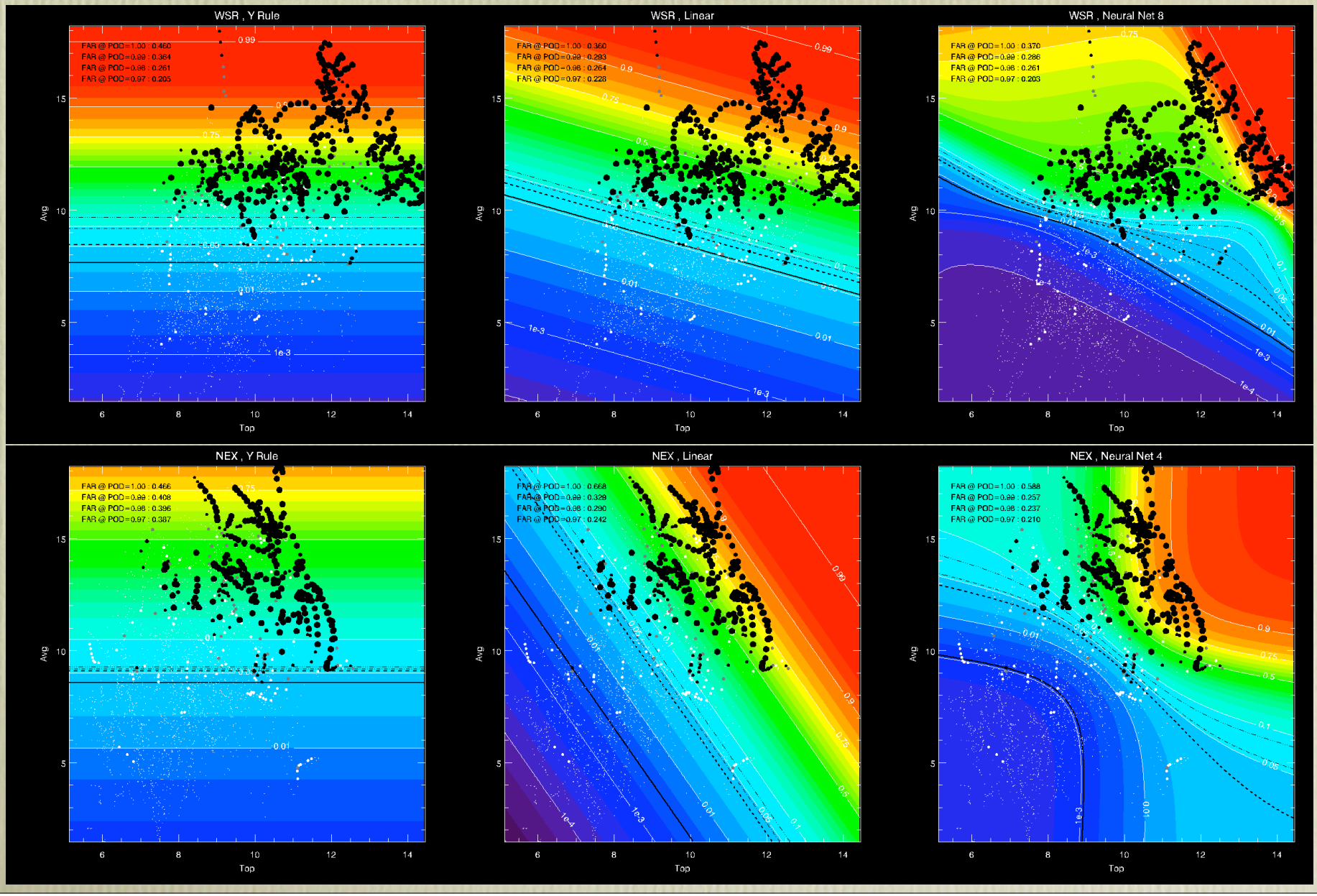
The POD=0.99, 0.98, thresholds are *very similar* to the WSR analogues, and again reduce FAR

The datasets *essentially agree*, in a "big picture" sense, if we're realistic about outliers.

Again, these models are *not* "less conservative" than Avg-rules. Arguably, they are "more conservative" ... they paint regions with *no actual hazard observations* as hazardous.



Top and Avg, WSR & NEX, side-by-side



Example conclusions

- Both WSR and NEX overall "agree", though outliers drive actual decision thresholds. This problem would *only get worse* with larger datasets.
- Both suggest Avg thresholds would be "OK".
- Both also suggest that such thresholds *ignore* an important feature of the data, that lower Avg is required in higher-topped clouds to yield a hazard. (This is physically plausible conclusion).
- Extrapolation of this conclusion *within the sampled data* to undersampled portions of our data space (e.g., the lower right of the plots) is legitimate, especially if we aim for both conservativsm and efficeincy.